Volume 18 April, 1932 *Number 4*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

The Use of Oil as a Quenching Medium in Heat Treating

Function and Lubrication of the Flexible Coupling

PUBLISHED BY

THE TEXAS COMPANY

TEXACO PETROLEUM PRODUCTS

Not Without Benefit of Quenching

WITHOUT quenching, the structural perfection of steel as we know it today would be unattainable. And so far no product has proved quite as effective for this quenching as petroleum oil.

The kind of quenching oil best suited depends upon the quenching temperature, the size and shape of the steel and the design of the quenching system.

It is therefore essential that there be available a wide range of oils from which to choose—a range such as The Texas Company is in a position to offer in its complete line of products for this purpose. These oils begin with Texaco Quenching Oil A and end with Texaco Cavis Mineral Cylinder Oil. They include straight mineral and compounded oils, which, dependent upon operating conditions, will meet the requirements.

Engineering study is essential in determining which quenching oil is best; and The Texas Company's engineering service matches its products in every respect. This service will be found as helpful in the preparation of steel for industrial purposes as it has been in the protection of such steel after fabrication and assembly.

We welcome inquiries pertaining to this all important subject of quenching.

THE TEXAS COMPANY

Texaco Petroleum Products

135 East 42nd St., New York City

Atlanta, Boston, Butte, Chicago, Dallas, Denver, Houston, Los Angeles, Minneapolis, New Orleans, New York, Norfolk, Seattle

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Published by
The Texas Company, 135 East 42nd Street, New York City
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Vol. XVIII April, 1932 No. 4

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The Use of Oil as a Quenching Medium in Heat Treating

THE term heat treatment as generally applied to the preparation of steels for industrial usage, implies the subjecting of these products to sufficient heating followed by rapid or slow cooling, or vice versa in order to bring about certain physical properties according to the service which is to be required. Heat treating as generally understood comprises four distinct operations, viz.: hardening or quenching; annealing, normalizing, and tempering or drawing. Of the above, hardening or quenching is of chief concern to the oil industry, in that it alone may involve their products to any great extent. Tempering in oils is of course practiced but the limited range of temperature possible renders the use of such products inextensive.

In the hardening or quenching of steels effort is made to simulate the physical conditions inherent to higher temperatures by rapidly cooling the product down to room or working temperatures. In other words, the object is to attain a permanent preservation of the crystaline state of the metal, normally existant only when it is heated above a certain critical temperature range. The extent to which this will be brought about will naturally depend upon the degree to which the quenching medium brings about rapid and uniform cooling with the development of a minimum of internal stresses or strains.

While quenching is of course dependent upon the size and shape of the piece, for thereupon will hinge the extent to which uniform cooling will take place, the quenching medium is the essential factor in the problem. In other words, its specific heat, viscosity and capability of ready transmission of heat must be studied, along with the volume of the bath available, the provision for circulation and maintenance of a bath of uniform temperature, and the vaporizing tendency of the medium.

TYPES OF QUENCHING MEDIA

The several media which can be utilized for the quenching of steel in heat treatment and hardening work include brine, water, soda ash solutions, glycerine, fixed oils of animal or vegetable origin, or petroleum oils. There are certain relative advantages pertinent to each, dependent upon the speed of quenching desired and the degree of hardness necessary.

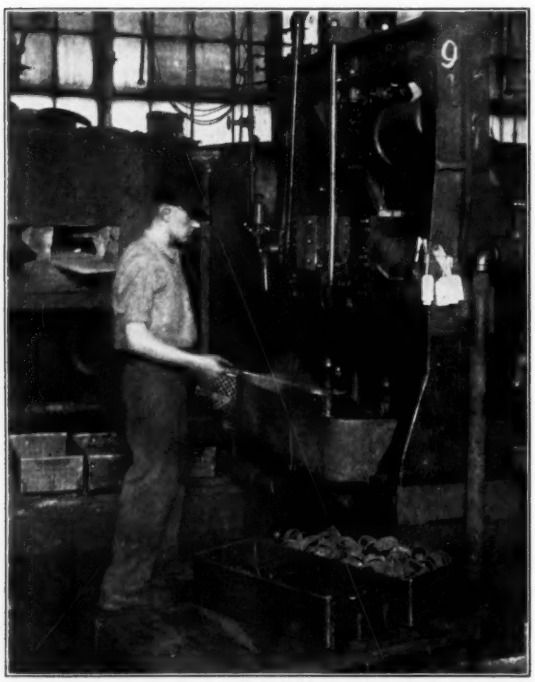
Mineral oils may be said to have the most adaptable characteristics to meet the varied nature of the requirements encountered in the average plant.

For alloy steels quenching in air is productive of admirable hardening results but the operation requires skill, careful attention, and a perfect circulation of the air currents, otherwise unequal cooling of the steel may result. For this reason many steel treaters prefer to quench in liquids.

Water, and Brine Solutions

Water naturally was the first medium that was used in this manner, due probably to its availability and cheapness. But water with its

high specific heat and its capability, thereby, of rapidly absorbing heat, is productive of extremely rapid cooling. Furthermore, unless chemically pure it may contain insoluble salts, fatty matter, or acids with the resultant possibility of these latter causing brittleness or so insulating the steel as to render



Courtesy of The Timken Roller Bearing Company

Fig. 1—Showing toggle press in operation of hardening cones. Here the heated bearing parts are quenched in oil, using a plug to hold parts true to size and reduce distortion and warpage.

cooling uneven and the ultimate hardness a variable.

Brine solutions or water solutions of other salts or perhaps soaps are also used for the quenching of certain grades of steel where results differing but slightly from a water quench are desired. Brine or salt solutions by virtue of their specific heat give extreme hardness due to the high rate of cooling developed. Soap solutions vary just the other way, but not to the same extent as do oils.

On the other hand, we must remember that the necessary rapid rate of cooling involved will always have a certain tendency to bring about internal stresses within the steel, due to the degrees of its hardening. Any marked development of such stresses will naturally lead toward a straining or deformation of the internal structure which may cause cracking.

While it is possible to produce approximately the desired degree of hardness by quenching in a still liquid, more satisfactory and uniform results can be attained by the use of some means of agitation of the bath, or the steel itself can be made to circulate the bath by keeping it in motion while cooling is going on. Most uniform results can furthermore be obtained by keeping the temperature of the bath as constant as possible.

Water Requires Particular Attention

Use of water requires particular consideration of bath facilities in regard to circulation. If this is not brought about to a sufficient degree formation of a film of steam over the surface of the steel under treatment may prevent attainment of the desired results. Proper circulation, however, will break up such a film of steam and enable actual contact between the water and steel. Circulation can be brought about by spraying the incoming water into the tank, the steel being relatively motionless, or conversely, by agitating the pieces in the bath while quenching. Temperature of the bath can be controlled and kept within the desired limits by locating the outlet of the bath at the top, running water through the tank during the period of cooling. Regardless of bath conditions, however, water is limited in the extent to which its quenching power may vary. Where accurate control is essential, water may present restrictions which can be overcome by use of mineral oils of suitable viscosity or oils compounded with certain small percentages of high grade animal fats. Water, on the other hand, has been proved of distinct advantage where carbon steels are involved.

Glycerine as a Quenching Medium

To develop an intermediate between water, brine solutions and oil, glycerine has been studied by certain authorities, covering not only the straight chemical but also solutions with water in varying percentages. Data indicates that while pure glycerine has a slower quenching power than oil, in solution with water, the rate of cooling is more rapid. Where so-called surface hardening is desirable, with rapid cooling, this is regarded as an advantage over certain types of oil. On the other hand, the cost with glycerine will frequently be higher. A distinct advantage, however, is that by reason of its comparatively high boiling point it will not decompose or break down readily on heating, or present any appreciable fire hazard.

Oils

Use of oils for quenching purposes originally involved products of animal or vegetable nature. Fish oils were particularly favored, whale oil being held in high esteem. In fact there are

steel treaters who still extol the virtues of this product. Whale oil, however, regardless of its quenching qualities is decidedly objectionable due to the offensive odor which is given off when it is heated. Other types of fish oils are subject to this same objection. Such products also tend to become gummy after a certain amount of service, increase in the body of the oil will affect the quenching speed, causing it to be reduced if the oil becomes particularly heavy.

This latter holds true likewise for vegetable oils of the cottonseed and linseed variety. A certain amount of oxidation can also be expected with such products. Odor, however, is not as offensive as with fish oils.

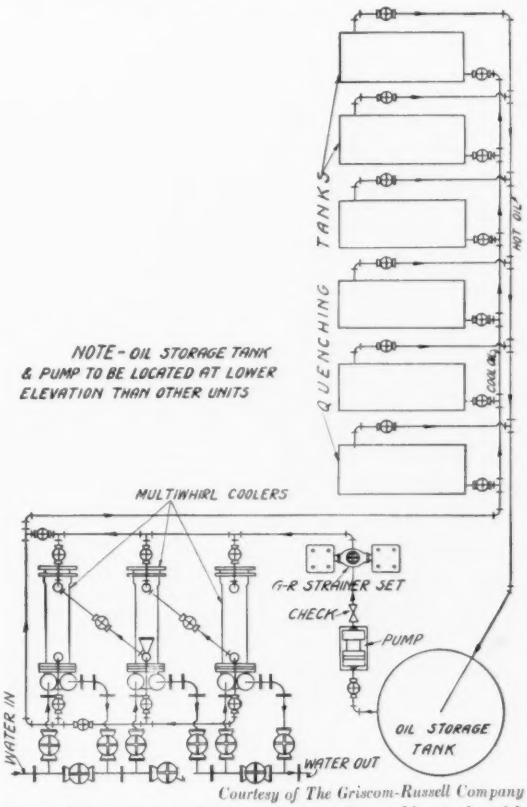
Lard oil and tallow have prevailed longer than the majority of other fixed oils which have at times been studied from a quenching point of view. These oils by themselves are not entirely suited to continued quenching service, inasmuch as they become rancid after extended usage. This, however, will depend to a certain extent upon the grade and refinement.

As a component part of mineral quenching oils, however, both are held in considerable favor. As a general rule they are used in comparatively low percentages, compounded with low to medium viscosity straight mineral oils. Products of this nature have been found to give a high degree of uniformity in regard to hardening operations, especially where means are provided for maintaining comparatively low quenching bath temperatures by proper cooling of the quenching medium.

Cooling of quenching media is of distinct advantage where mineral oils or mineral oil compounds are used, for it prevents undue thickening or increase in viscosity. In this respect it is important to remember that mineral oils when subjected to heat will tend to vaporize more or less, loosing their more volatile hydro-carbon constituents and thereby becoming heavier or of increased viscosity. Inasmuch as increase in viscosity may tend to reduce the quenching speed of a given oil, the degree of hardness ultimately attained in the steel under treatment will be directly affected, for hardness varies directly as the speed of quenching. This is entirely obvious when one considers that the rate of heat transfer through the oil is involved, and the heavier or more viscous this product the slower will be the rate at which the steel is cooled or the heat transferred from same to the oil. In fact, very often complaints as to insufficient hardness can be solved by studying the quenching system. Inadequate cooling methods and means for oil circulation can often be traced as the cause, rather than the original nature of the oil, the actual quenching temperature or the quality of the steel. Proper cooling and oil circulation also aid in reducing the tendency of a quenching oil to oxidize.

QUENCHING POWER

Mention has already been made of the fact that the quenching power of any oil will be



Courtesy of The Griscom-Russell Company

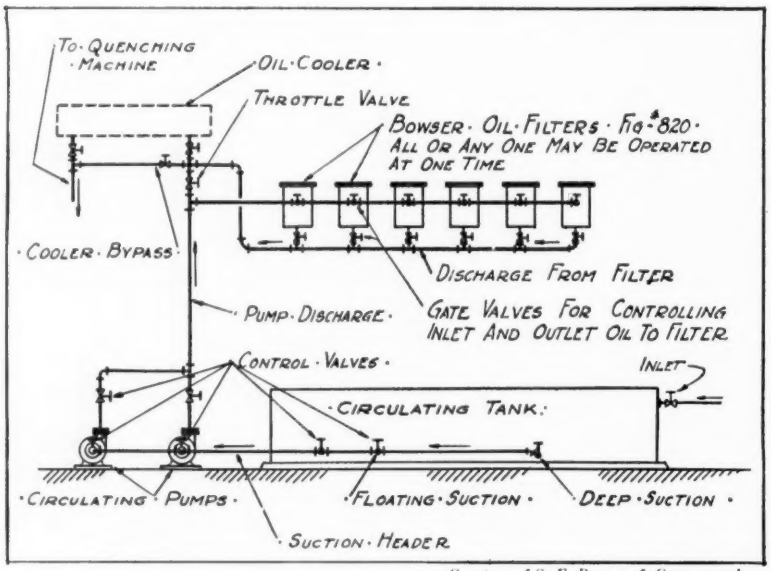
Fig. 2—Piping diagram showing a battery of quenching tanks with multiwhirl coolers connected in series.

dependent upon its viscosity. This is worthy of further discussion in the realization that it is generally considered that the lighter the oil the more effectively will it quench. It follows, in consequence, that an oil may normally be expected to decrease in quenching power in accordance as it may increase in viscosity. On the other hand research has indicated that the opposite may be true where certain heavy oils are added to carefully selected lighter products.

The effect of viscosity on quenching speed is decidedly important, inasmuch as practically all mineral oils will have a tendency towards vaporization under higher temperatures. Especially is this true of mineral oils which have not been closely fractionated. Such products will contain certain percentages of lighter, more volatile hydrocarbons which will readily vaporize, often at temperatures below the flash point of the main body of the oil.

As a result, in quenching a piece of steel from

say 1800 degrees Fahr., although the surface vapors are not heated sufficiently to fire continually, they may nevertheless flash momentarily. Just so much of the original oil in the bath is thereby lost, rendering the remainder slightly more viscous. The repeated occurrence of this phenomenon may ultimately raise the viscosity of any quenching oil sufficiently to lower its quenching power materially.



Courtesy of S. F. Bowser & Company, Inc.

Fig. 3—Diagram of a quenching oil system showing manner of connecting circulating pumps and oil filters.

The addition of heat, however, brings about a decrease in viscosity as the temperature-viscosity curve shows. But the maintenance of any quenching bath at continually higher temperatures approaches fire hazard limits just that much more. Therefore, best practice dictates:

1. Selection of the most closely fractionated, carefully refined oils available.
2. Maintenance of the initial or working temperature of the bath as low as possible and
3. Addition of sufficient make-up oil to replace that lost by vaporization.

In time, of course, the relative viscosity of the main body of any oil will be increased to a certain extent, though rarely sufficiently to affect the ultimate hardness of the steel.

This apparent loss of quenching power, of course, is not as evident in brine or water. In this connection research has proved that the former quenches faster and retains its quenching power better when subjected to higher temperatures. Water, of course, possesses the inherent fault of developing a film of steam around the metal, as already stated, which may materially affect the subsequent structure and hardness of the metal. Furthermore, water will often cause excessive distortion due to the rapidity with which it brings about cooling.

The ideal is to design the quenching system as to cooling and circulation, and to choose a quenching medium commensurate with the size of the steel to be treated and the degree of hardness desired, whereby cooling through the approximate critical temperature range (i.e., 900 to 700 degrees Cent.) will be sufficiently rapid, being retarded as the steel becomes less plastic, to insure against possible cracking.

REQUIREMENTS OF A QUENCHING OIL

In order that a petroleum product may be effective as a quenching oil, it must be capable of meeting certain very definite requirements. Just because it will give a moderately satisfactory degree of cooling is not sufficient, for the extreme care with which modern steels are quenched, drawn, tempered, etc., to meet the most exacting specifications requires a very definite rate of cooling. As a general rule, this must be determined by experimentation, due to the wide variety of conditions involved. The chemical nature of the steel, the extent to which it must be hardened, etc., the physical characteristics of the oil, the type of furnace, and the size and design of the cooling vat all enter into the problem. With all these various inter-related conditions, however, it is quite feasible to meet them provided they are not abnormal and the quenching oil is:

1. Capable of developing fairly high quenching speeds.
2. Fulfilling the above uniformly over a relatively wide range of temperatures, i.e., at least 100 degrees.
3. As free as possible from volatile constituents, in order to insure stability and preclude change in viscosity or body due to excessive evaporation under the higher temperatures so frequently involved.
4. Capable of ready removal from the steel being quenched.
5. Able to retain its quenching power and other characteristics over a suitable length of time.

PURIFICATION OF QUENCHING OILS

After a quenching oil has been in service for any length of time, however, it will normally tend to become darker in color due to oxidation, a certain amount of carbonization under higher temperature conditions, and the natural entry of dusty or dirty foreign matter. Of course, all this may promote the formation of more or less carbonaceous scale on the surface of the quenched stock. In effect the new oil may have been admirably suited for the work in hand, due to its low carbon-content, but extensive continuation of the above might easily render its use absolutely prohibitive. This would be especially liable to occur where the quenching vats are too small, the flow of oil through them too slow, or the final temperature allowed to rise too high.

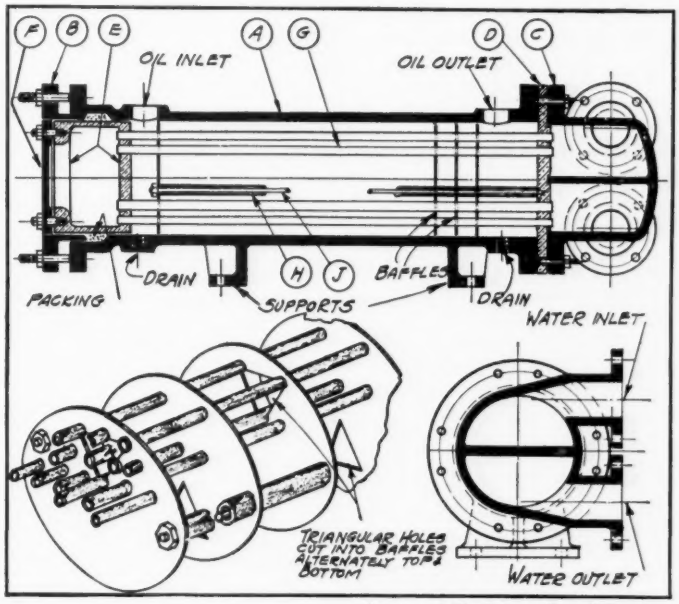
To insure against the use of impure or carbonized quenching oils, means should be installed for purifying these latter wherever possible, either by batch treatment, or partial or continuous bypassing of part or all of the oil in service. There is but little difference between the carbonaceous foreign matter in a quenching oil, from that in a used turbine or engine oil. Therefore, the same means of oil purification involving either centrifugal force, filtration or coagulation should usually be readily adaptable. Of course, such an installation would be fairly costly, just as the use of a high grade filtered oil would be, but apportioning of such seemingly excess costs over the thousands of tons of treated steel handled per year in the average plant would show but a very low increased unit production cost per ton. This would be far more justified than running the risk of having to junk an entire batch.

Another factor which should be an influence in this regard is the possible effect which contaminating foreign matter may have upon the quenching speed of the oil. In the opinion of some steel treaters this may be material, the tendency being for the oil to have its quenching speed reduced, as it becomes contaminated. Assuming this to be consistently true, one can readily appreciate that the benefits which certain authorities feel are derived from using animal fats in compound to improve the quenching speed, might be offset by the presence of contaminating foreign matter.

CARBON IN OIL

The possible detrimental effects of carbon accumulations in a quenching oil are also worthy of discussion. In the opinion of certain steel treaters, it is important to guard against the formation of carbonaceous particles on the surface of the stock. This is generally the direct result of the use of dirty or high carbon content oil. In the process of quenching, this carbonaceous foreign matter in the oil, under the action of heat, may tend to attach itself to the metallic surfaces under treatment. Whether a direct chemical action takes place is a point of contention as yet. At any rate, when the stock is removed from such oil as above, adhesions in more or less intensity will often be plainly evident. Some of these will be jarred or broken off in subsequent handling, and where the stock receives but one quench—in oil—the remainder may have to be chipped off, or removed by a sand blast, or by pickling in acid.

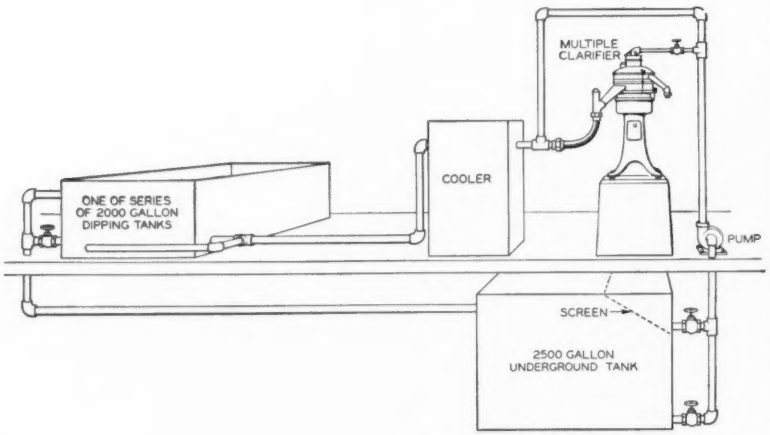
Where the stock includes high carbon or alloy steels, such as are used for tools, bearing elements, hack-saw blades and certain other products where a tough core with a hard surface is essential, a secondary and often a third quenching is necessary, using a water and brine solution. The primary oil quench is claimed to toughen the entire structure of the metal. The latter is then returned to the furnaces, heated to the requisite temperature according



Courtesy of The Griscom-Russell Company

Fig. 4—Structural details of a multiwhirl cooler used in quenching oil service. A—Indicates Shell; B.—Stuffing Box Gland; C.—Water Head; D.—Water Head Tube Plate; E.—Floating Head Tube Plate; F.—Floating Head Tube Plate Cap; G.—Tubes; H.—Separators; J.—Tie Rods.

to its alloy or carbon content, and then quenched in water. This sharp, sudden cooling tends to render the surface of the necessary hardness, the core, however, remaining sufficiently tough to meet the exacting stresses, strains and shocks of subsequent operation.



Courtesy of The De Laval Separator Company.

Fig. 5—Layout of a quenching oil system wherein a centrifugal clarifier is used for purifiying the oil.

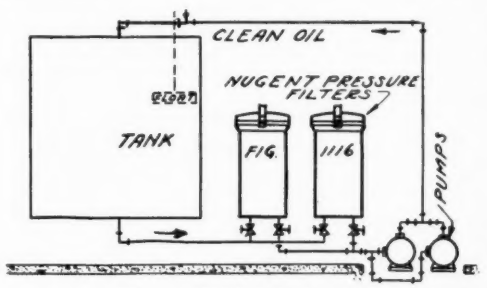
Where desirable, to intensify this condition, or meet exacting specifications, a third heat, with a final quench in brine solution, may be carried out.

In reheating treatment, after a steel has been quenched in oil, in the opinion of some there is possibility of carbonaceous adhesions altering the carbonaceous structure of the surface of the metal. Carbonaceous scale, resulting from quenching in dirty or high carbon content oil, may be of relatively lower carbon content than the adjacent steel. In the process of reheating, it is possible that a certain amount of decarbonization of the stock may occur, the surface formations absorbing some of this carbon until a point of equilibrium is reached. This detrimental effect of carbonaceous scale may prove ruinous to a piece of very accurately alloyed steel, therefore, the adherents to this thought feel that every effort should be made to oil-quench with as little of such formation as possible. With new or reclaimed oils this is perfectly possible of attainment by using straight mineral filtered products. Filtration of mineral oils effectively reduces their free carbon content to an extremely low percentage. For this reason, filtered oils when new are lighter in color than non-filtered products, for it is the finely divided carbonaceous matter in suspension which gives the darker colors. This is why certain steam cylinder oils are so much darker than motor oils, as tests of their relative carbon content will show.

POSSIBLE EFFECT ON COLOR OF STEEL

In the treatment of certain types of tool steel or small parts such as are used in construction of textile machinery, the ultimate color of the steel may be a factor. This is of particular importance in the treating of wire steel where the process of wire drawing may have developed a film of insoluble lime compounds on the surface of the wire as it is drawn through the dies.

Where such steel must be subsequently hardened to fit it for such service as knitting machine needles, the development of a perfect and uniform finished surface, and the prevention of rust or corrosion during storage must be given as careful consideration as attainment of the required degree of hardness. Normally such steels will be heated to about 1500 degrees Fahr., using a compounded quenching oil of a viscosity in the neighborhood of 100 to 125 seconds Saybolt at 100 degrees Fahr. Following the quenching and drawing processes, the finish may be improved by subjecting the parts to a process of tumbling, whereby the abrasive action of fine pebbles is employed as in a ball mill. Where lime drawing compounds have been used even tumbling does not always entirely polish the surfaces of the steel parts. The ideal would be to so treat the steel as to remove this apparent coating of insoluble lime prior to or during the quenching process, and experimental work to this end is being carried out at present by certain machinery builders. It is felt that attainment of this objective may tend to improve the uniformity of color in the finished products and lead to more effective retention of a rust preventing film of lubricant throughout the life of the parts.



Courtesy of William W. Nugent & Company, Inc.

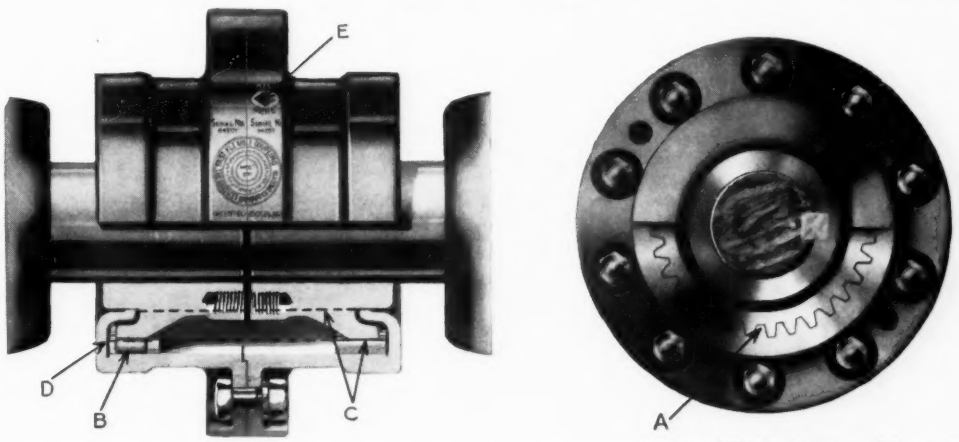
Fig. 6—Showing layout of a filtering and circulating arrangement for quenching oils.

Function and Lubrication of the Flexible Coupling

The extent to which the flexible coupling has become a standardized element in the transmission of power over the past 30 years has been distinctly interesting. It has been brought about by increase in power developments and the necessity for higher speeds.

The flexible coupling has proved to be the solution of this problem of existing or potential misalignment, with the result that its usage is accepted as standard in the accomplishment of power transmission.

In performing its function as a means of compensating for misalignment, shock, or vibration, the flexible coupling is reacted upon by both lineal and lateral misalignment.



Courtesy of The Bartlett Hayward Company

Fig. 1—Cutaway view of the Fast Self-Aligning Coupling. A.—Indicates oil film between gear teeth maintained by centrifugal pressure; B.—Indicates location of load carrying surfaces wherein oil carries the load; C.—Indicates oil levels when the coupling is idle and in operation; D.—Indicates clearance to allow for free lateral float of each shaft.

In the opinion of certain authorities this has been largely responsible for the trend toward direct drive and reduction in use of belt connections. Use of the flexible coupling has also been influenced by the popularity of steam turbines and the practicability of designing these latter to suit a wide variety of power transmission requirements.

If it had been possible to maintain coupling connections between power transmission machinery in perfect alignment, there would have been no necessity for the flexible coupling. In actual operation, however, it was developed that perfect alignment was virtually impossible. As a result, coupling of power generating or transmission machinery must be studied with due regard for existing misalignment or development of this latter. The ideal, of course, would be to design so that perfect alignment would be possible, for thereby can power be transmitted with the minimum of lateral resistance. Actually, however, this ideal cannot be attained, or, due to existing structural conditions, misalignment may develop after the equipment has been put in operation. Obviously, such a condition must be anticipated in the interest of maximum power transmission, and reduction of the possibility of premature wear of bearings.

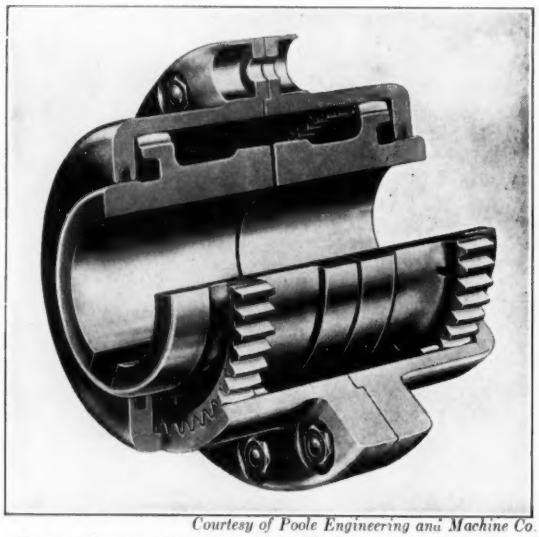
Lubrication

In studying the lubricated flexible coupling, it is important to remember that each type should be analyzed from the view point of its individual lubrication requirements. This is particularly advisable in view of the fact that in many plants there will be more than one type of lubricated coupling in service. Experience has indicated that lubrication plays an important part in enabling virtually any type of lubricated coupling to take care of the operating conditions mentioned above.

It is also important to remember that the life of any such coupling is dependent upon the use of proper lubricants, and the extent to which these latter will prevent wear. While the average coupling is but a small piece of equipment, it is the determining factor in regard to the reliability of the connected machinery.

As a rule, only a small quantity of lubricant is required, but it must be of the proper kind. Couplings wherein lubrication is essential involve some sort of spring or gear construction, an arrangement of flexible pins or an intermediate element in the form of a cross. Those

in which solid pins and bushings, rubber, leather, or other forms of fabric flexing elements are used, will in general require no lubrication. The lubricated type is of particular interest, due to the variety of construction involved.



Courtesy of Poole Engineering and Machine Co.

Fig. 2—Showing sectional view of a Poole gear type oil-lubricated coupling. This coupling contains a composition packing ring at each end to exclude dust and dirt.

They may be divided into two broad classes, according to whether they are designed for oil or grease lubrication.

Care of Lubricated Couplings

In the operation of any lubricated coupling, it is essential to remember that the possible entry of abrasive foreign matter such as dust, dirt, etc., may materially impair the protective ability of the lubricating film, and result in wear of the coupling parts to such an extent as to render the entire mechanism incapable of performing its intended function.

Experience has dictated that periodic inspection is highly advisable; at the time of such inspection not only can abnormal misalignment between the connected machines be corrected, but at the same time the coupling can be flushed out with a comparatively light oil, in order to remove any gummy accumulations, dust or abrasive dirt which might otherwise materially reduce the life of the coupling.

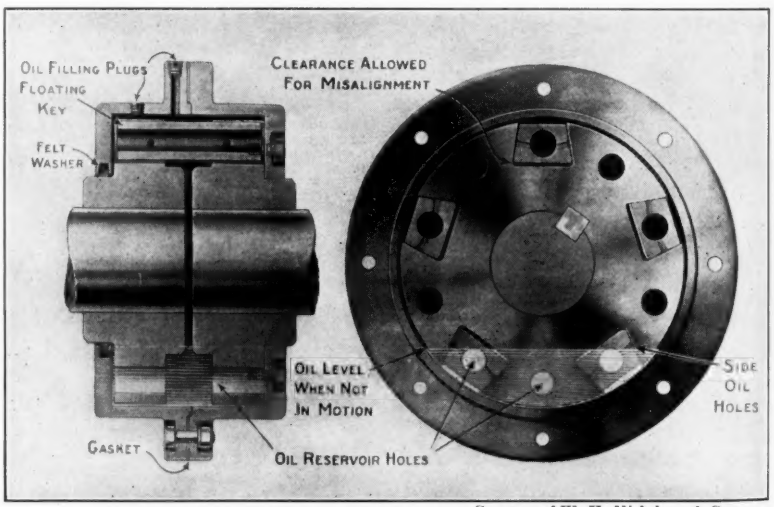
OIL LUBRICATED COUPLINGS

Oil lubrication has proved highly desirable for flexible couplings of the gear type, as well as for those involving floating keys and laminated pins.

Geared Devices

The principle of "double engagement," i.e., the combining of two single engagement couplings into one mechanism, has been worked out in a most interesting manner in certain gear type devices. Flexibility is due to design rather than to the materials used. In this type of coupling (see Fig. 1) two sets of internal and external spur gears are involved. The external elements are cut on the two hubs which are pressed and keyed to each shaft. The internal gears are cut in the surfaces of two companion floating sleeves; in operation they mesh permanently around the entire circumference with the gear teeth on each hub. By virtue of the design and the existing clearance between the ends of the sleeves and the hubs, the shafts are subject to free adjustment. Yet, the shafts and sleeves revolve as one unit, the enmeshed gears compensating for any lateral or angular play.

Another design (Fig. 2) employs internal gears at each end of a floating sleeve which mesh with corresponding sets of external spur gears cut on the end of each shaft hub. Spherical formation of the teeth of these latter gears enables free rocking action according to shaft misalignment requirements. All gears are permanently in mesh around the entire circumference, giving the maximum of load-carrying capacity.



Courtesy of W. H. Nicholson & Company

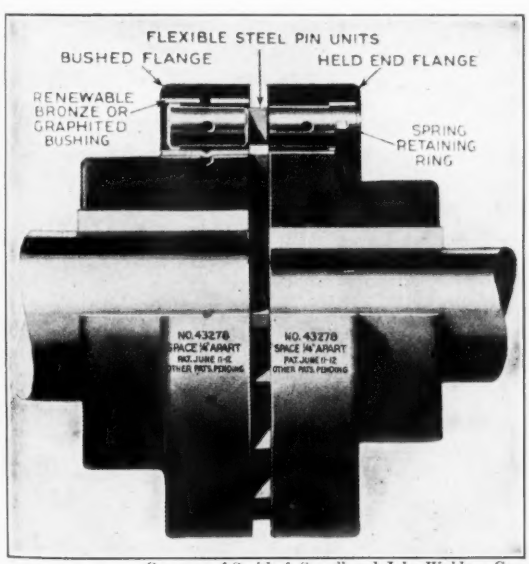
Fig. 3—Details of the Nicholson floating key type coupling, showing constructional details, location of oil, and provision for sealing.

The method of sealing couplings of this latter type against entry of dust, dirt, grit or moisture is of distinct interest. A highly resilient type of oil-resisting packing ring seal is inserted in a tapered groove between the end plate and hub at each end of the coupling. It is claimed that such a seal does not impair flexibility; at the same time it aids retention of oil and exclusion of foreign matter. As a result, carrying high oil level should not lead to leakage.

Lubrication Requirements

By reason of the fact that constantly enmeshed gear teeth are involved, positive lubrication is a most important factor in the development of proper operation. It may even be stated that the design of such couplings has been predicated upon effective lubrication. Normally this is brought about by merely charging the coupling with a suitable grade of oil in accordance with the prevailing service, to a pre-determined level.

In operation continued maintenance of an adequate oil film between the gear teeth is brought about by a pumping action between the load carrying surfaces, in company with centrifugal force and capillary action. The speed of rotation will affect the pressure involved due to its relation to centrifugal force. By reason of the variation of alignment this pumping action causes circulation of a renewed supply of oil to the load carrying surfaces twice during each revolution. This is virtually positive insurance against any lack of lubrication provided a sufficient amount of oil is maintained in the coupling.

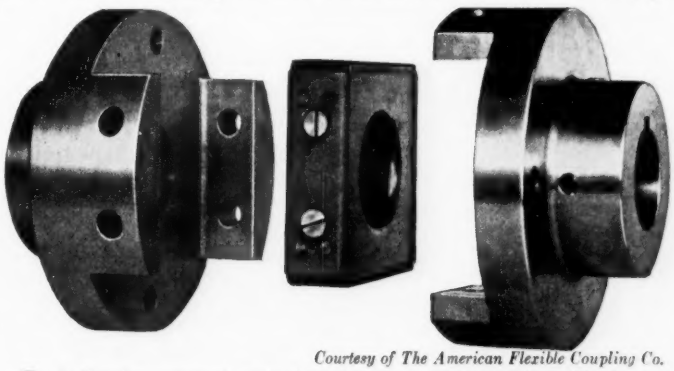


Courtesy of Smith & Serrell and John Waldron Corp.

Fig. 4—Showing a Francke bushed laminated pin type coupling; relative location of flexible steel pin units and other elements is referred to in text.

Type of Oil

The principles of design of the gear type coupling call for oil lubrication. The viscosity of oil to use, however, will be governed by the operating conditions. The normal range will be from approximately 100 to 1000 seconds Saybolt at 210 degrees Fahr., in other words, one would use a product ranging in body from that of an extra heavy motor oil to a medium heavy gear compound. It will all depend upon the size of the coupling and the temperature of operation.



Courtesy of The American Flexible Coupling Co.

Fig. 5—Showing component parts of the American Flexible Coupling. The floating center member is a hollow casting which should be filled with a light consistency grease. In rotation, centrifugal force causes this latter to pass through four small holes in each bearing surface and thereby maintain lubrication.

In northern climates, cold weather service would require an oil within the lower viscosity range, or even one lower than 100 seconds Saybolt at 210 degrees Fahr., whereas in certain steel or cement mill operations a heavy gear compound would be necessary in view of the viscosity reducing high temperatures which often prevail.

The Floating Key Type

The use of floating steel keys makes possible another type of oil lubricated coupling of all metal construction. One prominent design (see Fig. 3), comprises two cast steel hubs, each keyed to its respective shaft. On each hub dove-tail slots are cut wherein the steel keys are located in the final assembly. These keys float on a film of oil which is maintained by centrifugal force during rotation of the coupling. The keys are drilled to afford greater oil carrying capacity, and give more positive assurance of adequate lubrication at all times.

The number of keys used depends upon the size of the coupling. In the smaller types, three such keys are installed. Large couplings, however, are equipped with five keys. General construction of all sizes is such as to prevent

entry of dust and dirt, and enable oil retention with the minimum of leakage.

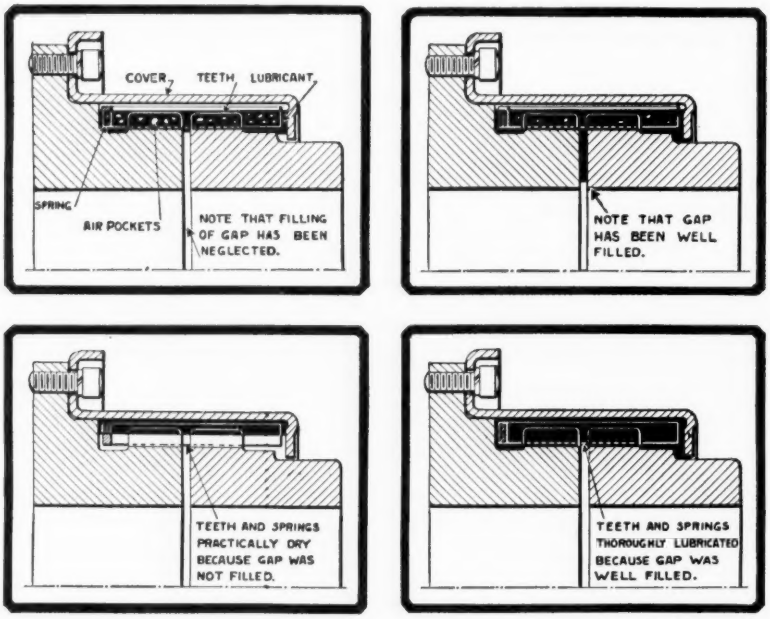
Lubrication

Flexible key type couplings are normally designed for oil lubrication. Circulation to and around keys is brought about by centrifugal force, the pressure developed in normal operation being sufficient to keep the clearance spaces between the keys and their respective slots completely filled with oil. There is as a result the minimum possibility of metal-to-metal contact, even under extreme conditions of misalignment.

Adequate oil distribution also facilitates more complete rocking action of the respective keys during rotation, thereby preventing localization of wear at any one point. Should extreme conditions cause metallic contact the resultant wear would be distributed along the entire side surfaces of the keys. Indication of effective lubrication is noiseless operation.

Nature of Oil

Constructional conditions of such couplings require the use of a medium viscosity, highly refined straight mineral oil, of from 300 to 500 seconds Saybolt viscosity at 100 degrees Fahr. Under low temperature operation the lower viscosity range should be used, selecting in addition an oil of as low pour test as possible to enable proper distribution when starting cold.


COVER
TEETH
LUBRICANT
SPRING
AIR POCKETS
NOTE THAT FILLING OF GAP HAS BEEN NEGLECTED.
NOTE THAT GAP HAS BEEN WELL FILLED.
TEETH AND SPRINGS PRACTICALLY DRY BECAUSE GAP WAS NOT FILLED.
TEETH AND SPRINGS THOROUGHLY LUBRICATED BECAUSE GAP WAS WELL FILLED.

Courtesy of The Falk Corporation

Fig. 6—Details of construction of the Falk spring type flexible coupling. Views to the left show wrong way to fill coupling with grease, the correct way being shown at the right. It is essential to eliminate air pockets and fill the gap between hubs completely with lubricant which should be a comparatively high consistency grease.

Provision is made for application of oil in the coupling shown in Fig. 3, through a lip at one side of the casing. Re-lubrication should be normally carried out when the coupling is at rest, filling to the level of the lip. Such couplings should be drained, cleaned and filled with fresh oil about once a year.

Pin Couplings

An interesting type of pin coupling has been evolved with the development of the bushed laminated pin device (see Fig. 4). In this coupling flexibility is brought about through the use of laminated steel pin units which are locked in place by a spring retaining ring in one of the flanges.

The use of such pins is regarded as providing an effective cushion where load shocks and vibration may occur.

Construction From View Point of Lubrication

The pins are inserted in bronze or graphited bushings in the flange which is opposed to the one in which the steel retaining spring is located. The use of graphited bushings will insure a certain amount of lubrication for an indefinite period, dependent upon the intensity of service.

Where service may be severe, however, continuous oil lubrication is recommended by the manufacturers, the coupling being enclosed in a suitable oil retaining casing. Such enclosure with the attendant provisions for lubrication will be of particular advantage where the coupling may be exposed to acids, moisture or an excess of dust, grit or other abrasive foreign matter.

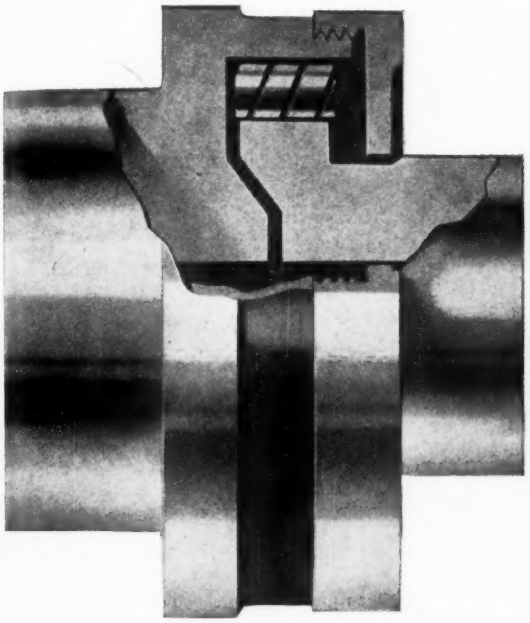
Double Floating Ring Design

An extension of the usage of flexible pins is also found in the double floating ring type of coupling. By using two sets of such pins a degree of flexibility is claimed to be attained which renders such a coupling adaptable to very severe operation, where correction of operating or structural misalignment can only be accomplished at infrequent intervals.

Lubrication Most Important

With the double floating ring coupling

positive lubrication must be provided for, in view of the fact that the extra misalignment capacity is derived from the movement of the floating ring with respect to the two sets of pins as well as the flexibility of the laminated



Courtesy of The Meriam Company

Fig. 7—Cutaway view of a Meriam flexible coupling. This device consists of two hubs connected by hardened steel rollers. A comparatively hard grease is essential for proper lubrication.

spring construction. For average coupling installations a medium viscosity highly refined oil has been found to be satisfactory, the oil case being filled until the oil level is nearly up to the lower rim of the coupling. This will enable the oil scoops attached to the floating ring to pick up oil continually during rotation. Oil passes through these scoops to be subsequently delivered to each flexible pin unit. It is important to remember that the holes in the oil scoops must be located in the direction of rotation of the coupling, in order to insure positive circulation of oil. Renewal of oil is advisable at regular intervals, to maintain the level in the case at the proper height.

Not all such couplings are oil lubricated however. The high speed type may require either oil or grease according to operating requirements. For this reason this type of coupling is designed so as to be capable of retaining grease, application of the lubricant being accomplished by suitable pressure gun fittings. It is practicable to install the high speed coupling in an oil case and lubricate it in a similar manner to the double floating ring type.

GREASE LUBRICATED COUPLINGS

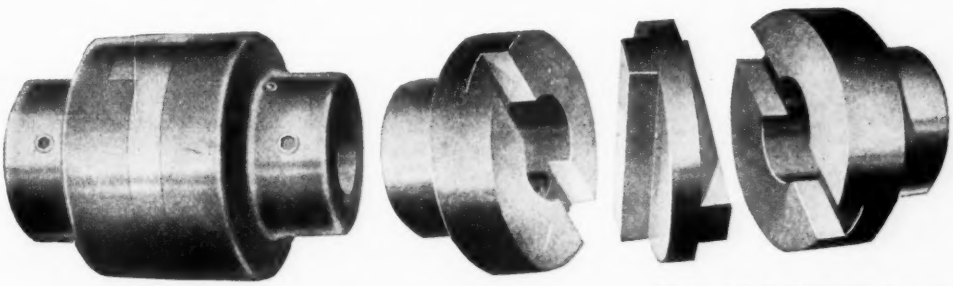
Grease in turn is also a practicable lubricant for certain designs of couplings, notably those of the spring and cross type.

Spring Type Couplings

Devices wherein construction embodies spring flexing elements, require suitably designed grooves which contain the springs. In the type shown in Fig. 6, these grooves are cut in the two steel hubs, widening toward the surface of contact of the hubs. As the spring bars are flexed in their respective grooves during any shaft adjustment under operation, they are caused to bend around the surfaces of the grooves. By virtue of designing the arc of curvature of the grooves with respect to the thickness of the springs, the stress on the springs is maintained relatively constant, thus insuring against fatigue or loss of elasticity.

Lubrication

Lubrication of this type of coupling is important and must be carefully carried out. The space between and around the springs must be so packed as to insure complete penetration of grease throughout the gap between the hubs, and the entire elimination of air pockets. In this way the space between the hubs will serve as a grease reservoir to prevent development

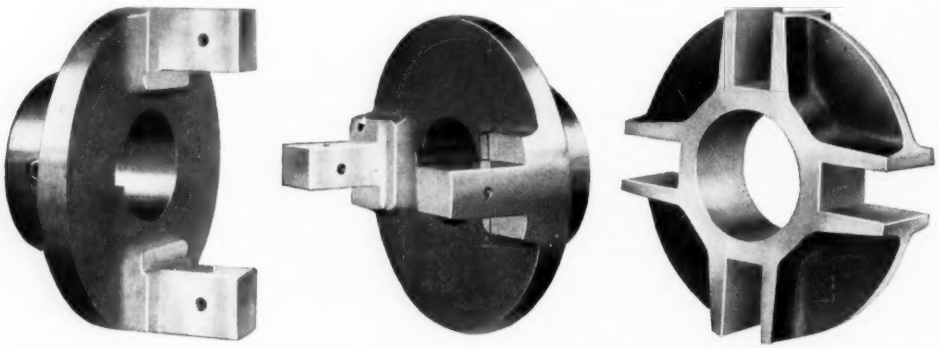


Courtesy of T. B. Wood's Sons Company

Fig. 8—Showing the Type D Universal giant flexible coupling in detail. The floating intermediate plate intermembers with the faces of both flanges. Sliding motion is facilitated by effective lubrication.

of air pockets around the springs during subsequent operation. This is brought about by the action of centrifugal force upon the grease in this space.

exist regardless of misalignment, can carry variable loads effectively and with but little possibility of abnormal wear, provided it is properly lubricated. Extensive study of the



Courtesy of Smith & Serrell and John Waldron Corp.

Fig. 9—Details of the Francke cross type coupling. This is a grease-lubricated device. In operation it should be half filled with a high grade medium consistency lubricant.

Cross Type Mechanisms

Flexibility in coupling design can be developed in another unique manner by using a form of cross member with suitable slots (See Fig. 9), designed to fit in assembly between the respective flanges. Contact exists between the protruding elements or keys on the flanges and the slots in the cross. To enable distribution of lubricant holes are drilled through each key as shown.

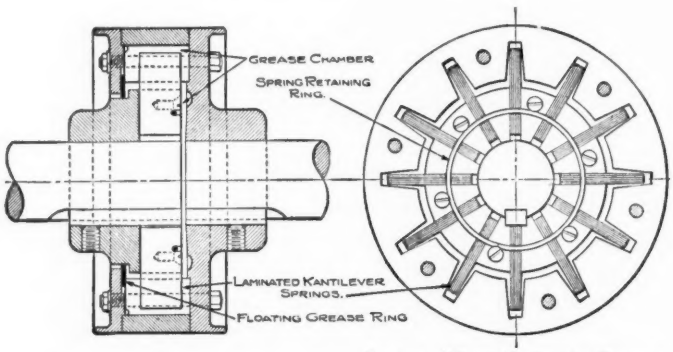
Lubrication

The cross-type coupling is a distinctly grease lubricated device. It is capable of affording flexibility in any direction, and by reason of the constant bearing areas which

lubricating requirements and operating possibilities of such couplings has indicated that a grease, containing a heavy bodied straight mineral oil will afford most positive and durable lubrication.

Pin Type Devices

It is also practicable to grease lubricate the bushed laminated pin type coupling



Courtesy of Brown Engineering Company

Fig. 10—Sectional details of the Brown Kanti-Lever flexible coupling. Note provisions for grease lubrication.

shown in Fig. 4. This will hold true particularly where low to moderate speeds prevail. In practice the coupling is packed with a medium consistency highly refined grease, containing an oil of fairly high viscosity. By use of suitable retaining cups and grease proof fabric which surround the coupling flanges in operation, prevention of possible loss of grease by centrifugal force is prevented.

Printed in U. S. A. by
EDGAR C. RUWE CO., INC.
72 Washington St., N. Y. C.